भारतीय मानक
Indian Standard

IS 16472 : 2016
(Reaffirmed 2021)

जलमार्ग के डिजाइन और निर्माण के लिए दिशा-निर्देश

Design and Construction of Water Courses — Guidelines

ICS 17.120.20

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March 2016 **Price Group 4**

Canals and Cross Drainage Works Sectional Committee, WRD 13

FOREWORD

The Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Canals and Cross Drainage Works Sectional Committee had been approved by the Water Resources Division Council.

Water course is a small channel to deliver water to each and every field in the command area of an outlet which is approximately 40 Ha for a delivery system of one cusec. Water course generally off takes from a minor or a distributary. Capacity of a water course depends upon (a) Water allowance, (b) Running period of outlet, and (c) Area to be irrigated.

IS 12379 : 1988 'Code of practice for lining water courses and field channels may be referred for lining of water courses and field channel'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DESIGN AND CONSTRUCTION OF WATER COURSES — GUIDELINES

1 SCOPE

This standard lays down the guidelines for design and construction of water courses.

2 REFERENCES

2.1 The Indian Standards listed below contain provisions which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
7986 : 1976	Code of practice for canal outlets
10646 : 1991	Canal linings — Cement concrete tiles — Specification (*first revision*)
12379 : 1988	Code of practice for lining water courses and field channels

3 DESIGN PARAMETERS

3.1 Minimum Chak (Command Area of an Outlet) Size

The minimum size of a chak should be such that the full command area to be served from the outlet is irrigated in a reasonable time. Generally it should be kept such that the discharge in the water course is 14 l/s to 30 l/s. Number of beneficiaries is also an important factor in deciding the chak size. Generally 10 to 15 beneficiaries can be served suitably. As the number of beneficiaries in a chak depends upon the sizes of the holdings, where the average size of holding is smaller, the chak size may be adjusted such that the maximum number of beneficiaries should not exceed 30. As far as possible the chak should lie in one village and should be restricted up to road/railway line/drainage crossing. The length of water course should be generally kept from 1 km to 3 km.

3.2 Location of Outlet and Alignment of Water Courses

While finalizing the location of the outlet, following aspects should be considered:

a) The outlet should be located upstream of drop/fall on parent channel;
b) The water course should command the area within short distance (generally within 15 m);
c) As far as possible water courses should not cross borrow pits;
d) To avoid the road crossing on water courses, if possible, the location of the outlet should be taken d/s of the canal road crossing.

3.3 Longitudinal Slope

Natural slope of the land decides the bed slope of the water course. Generally a bed slope of 1 in 1 000 to 1 in 2 000 can be provided depending upon different site conditions. In case of lined water courses, steeper slope like 1 in 1 000 may be adopted.

3.4 Working Head

Working head of 30 cm at the outlet should be kept. It is a usual practice to keep the water level in the field channel 15 cm higher than the ground level of command, it is designed to serve.

3.5 Transit Losses

The transit losses in a water course are due to (a) Leakage, (b) Evaporation, and (c) Seepage. Seepage losses can be accurately measured by ponding method.

3.6 Section

The minimum bottom width, full supply depth, free board and bank width in the case of earthen and lined water courses may be as given in Table 1.

Table 1

Type of Water Course (1)	Minimum Bottom Width (2)	Minimum Full Supply Depth (3)	Free Board (4)	Minimum Bank Width (5)
Earthen	30 cm	25 cm	15 cm in cutting and 30 cm in filling	30 cm
Lined	25 cm	30 cm	7.5 cm to 15 cm	30 cm

4 FIELD LAYOUT

The command area of a canal should be divided into chaks so as to obtain minimum chak size as described in **3.1**. The average chak size should be such that the discharge in the water course does not exceed 30 l/s.

The contour survey of the command area of the canal should be carried out keeping the grid size of 30 m × 30 m. The contour plan should be prepared to the scale of at least 1 in 1 000 to 1 in 1 250 by keeping the contour interval as 15 cm (for lands up to 1 in 100 slope) and 30 cm (for lands steeper than 1 in 100). The longitudinal section should run along the alignment and spot levels recorded at 30 m interval. Cross section across the alignment should be taken at 60 m interval and at the location of turnouts. The cross section should extend adequately on either side to decide the sill levels of turnouts, with respect to area it has to serve.

The chak boundaries should be kept so that length of water course does not exceed 3 km. The alignment of water course should generally be kept along the ridge line.

5 REQUIREMENTS OF GOOD DISTRIBUTION NETWORK

A good distribution system should satisfy the following requirements:

a) It should provide desired quantity of water economically and efficiently to each part of chak,

b) It should have enough capacity to meet crop water requirements during peak use periods, and

c) It should be large enough to allow delivery of water in the time allotted when water is supplied on rotation or turn basis.

6 DESIGN CAPACITY OF WATER COURSES

The capacity of water course should be decided taking into consideration the requirement as per water allowance, chak area and the losses in transit like seepage losses etc.

The design capacity can be computed as follows

$$Q = (AW/IT)\ \{1/(1 - L)\}$$

where

Q = design capacity of water course in cumec,

A = area to be irrigated in Square metres,

T = time of irrigation in seconds per day,

W = Water requirement for one irrigation in metres,

I = irrigation period in days during one watering, and

L = water conveyance losses as a decimal.

NOTE — Often an extra capacity up to 25 percent is added to provide for unexpected requirement of irrigation.

7 DESIGN OF WATER COURSES

a) The minimum bottom width, full supply depth, free board, water surface slope and bank width in the case of earthen and lined water courses should be as given in **3.6;**

b) The section of the earthen water courses should generally be trapezoidal having side slope as 1.5(H) : 1(V). In fine textured soils like black cotton soils the side slope should be 2.5(H) : 1(V) and in hard murum it should be 1(H) : 1(V) ;

c) The section of the lined water courses should be trapezoidal, rectangular or semicircular etc depending upon the type of lining ;

d) Manning's formula should be used to decide the parameters like bed width and full supply depth. Minimum driving head available at the turnout should be 15 cm; and

e) The velocity in the unlined field channel should be non-erodible. The permissible velocity in various types of soils should be as follows:

Sl No.	*Type of Soil*	*Permissible Velocity* (m/s)
(1)	(2)	(3)
i)	Silt	0.45
ii)	Black cotton soil (Fine texture soil)	0.5
iii)	Clayey loam	0.65
iv)	Soft murum	0.8
v)	Grass sodded section	0.9
vi)	Hard murum	1.0

8 LINING

For lining of the water courses IS 12379 should be referred to. Lining of the water courses has the following benefits:

a) Reduction of water losses to a negligible quantity;

b) Facilitates planned division and sub-division of discharge ;

c) Reduction in the width of land lost under the water course section (lined channels need reduced section);

d) Prevent water logging adjoining the water course; and

e) Reduction in operation and maintenance cost.

9 WATER CONTROL STRUCTURES

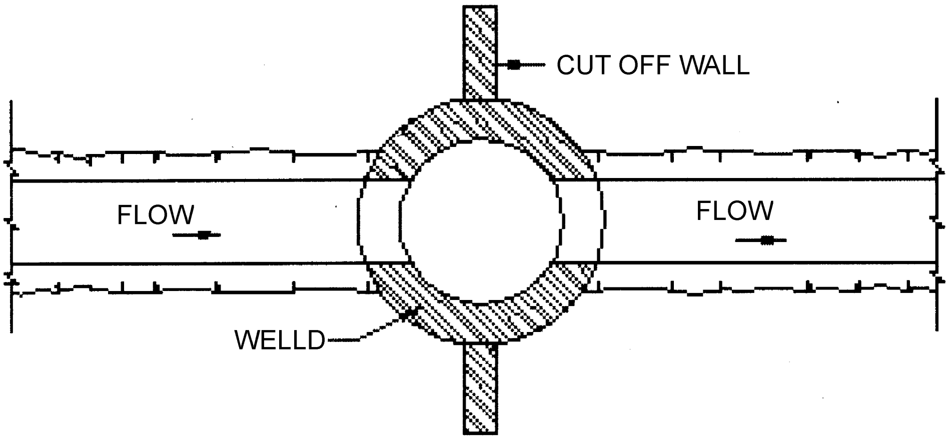
Water control structures are provided to control and deliver the water to the field.

9.1 Outlets

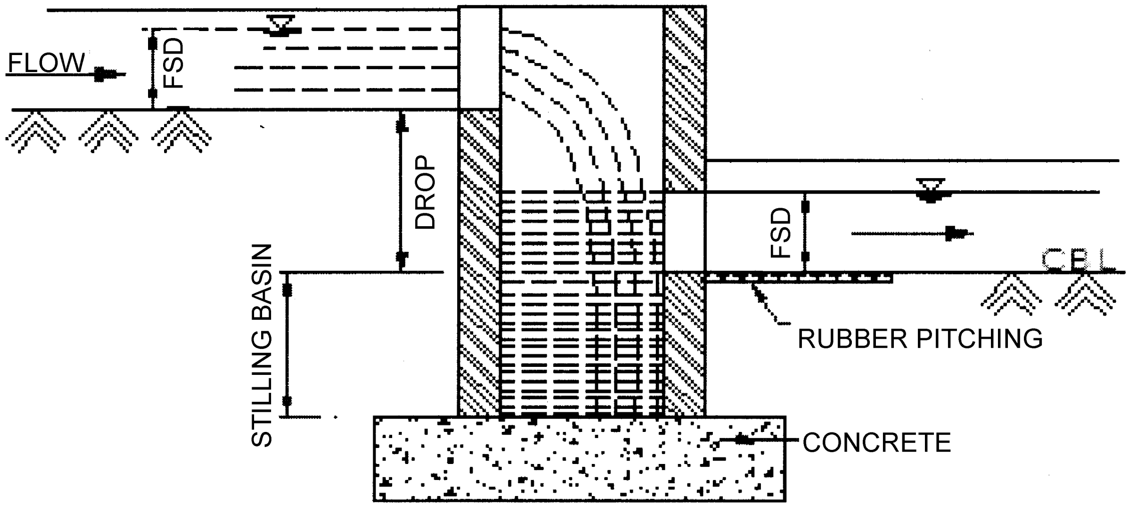
Outlet is a device built at the head of the water course to control the flow of water in it. These are provided to deliver the water from the distribution system to the field and are generally in the form of flow pipe. The quantity of water delivered should depend upon the head of water and the size of the cross section of the outlet. The outlet should be in accordance with IS 7986.

9.2 Drops

The drops in the field channels are basically similar to those on the distributory or main canal and their functioning is the same. The only difference is that these structures are small in size but large in numbers and hence their construction has to be simpler. These structures are made of concrete, brick or stone masonry and are used to prevent erosion in the channel laid on highly sloping land. The drop should not exceed 0.50 m to 1 m. To minimize the cost, the number of drops should be minimum. The number of drops will depend upon length of water course, bed slope and permissible velocity. A typical well type drop structure and vertical rectangular drop structure is shown at Fig. 1 and Fig. 2 respectively.

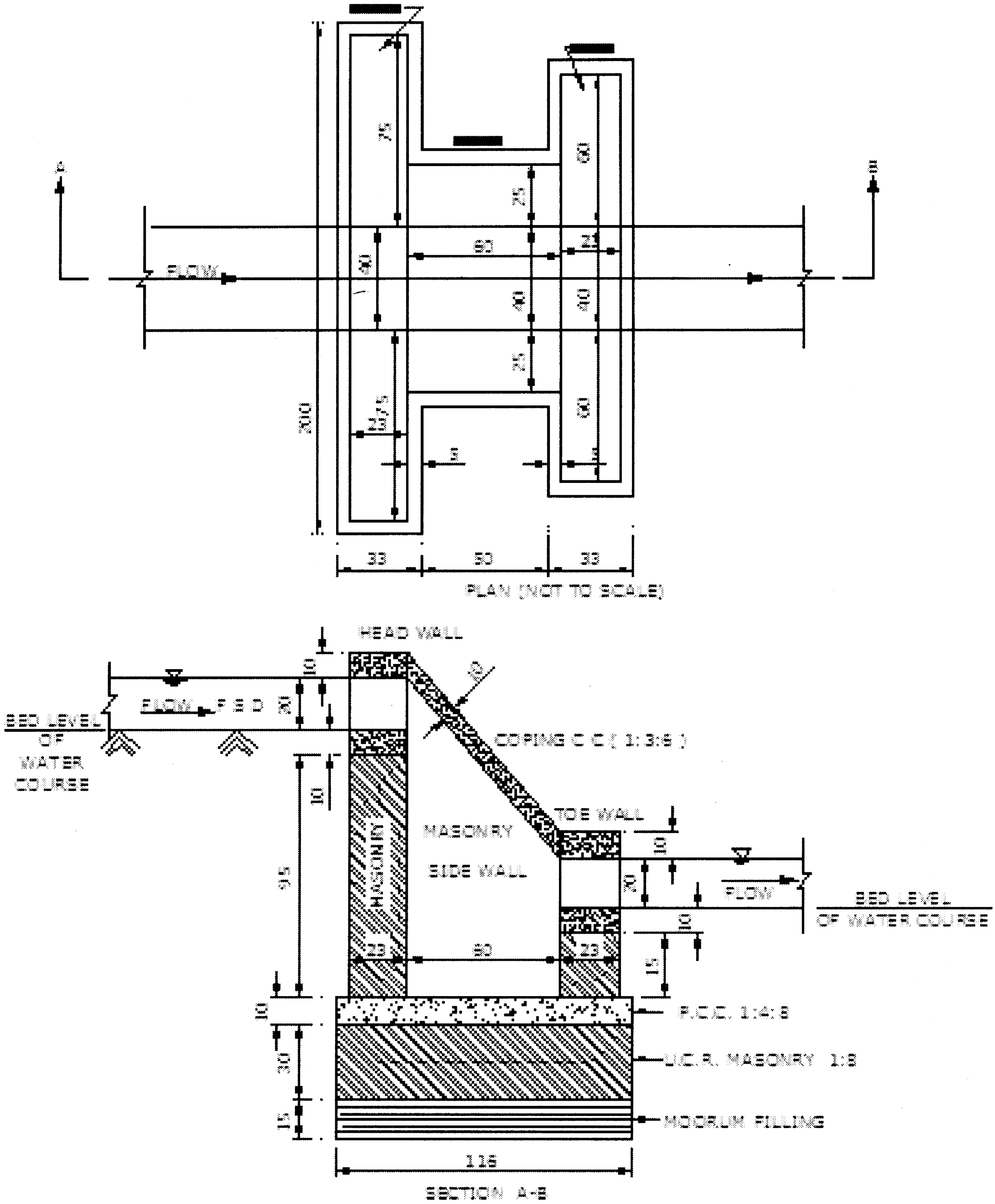


PLAN
(NOT TO SCALE)



ELEVATION (NOT TO SCALE)

FIG. 1 WELL TYPE DROP STRUCTURE



All dimensions in centimetre.

FIG. 2 VERTICAL RECTANGULAR DROP STRUCTURE (NOT TO SCALE)

9.3 Division Boxes

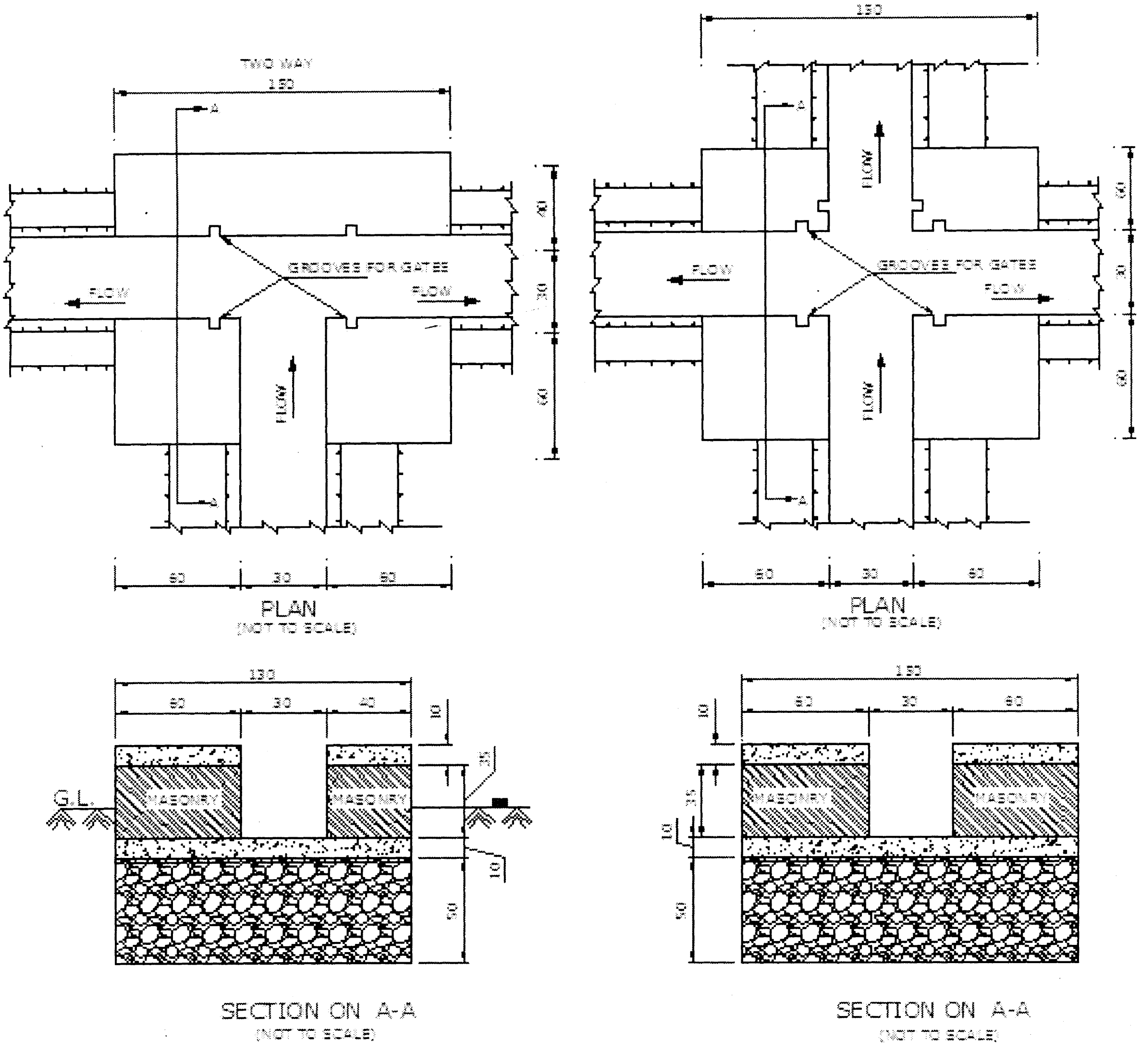
The diversion or division boxes are provided in the field channel where it branches off in two or three directions. The purpose of the box is to divert the flow into any one branch. These are made of concrete boxes, brick or stone masonry with two or more rectangular openings to divert the water from one field channel to other. Often these boxes are provided with gates and the width of each outlet is proportional to the division of water to be made. The division structure may be separate structure or may be the outlet of a siphon or drop or turnout from which further diversion is required. A typical division box is shown at Fig. 3.

9.4 Checks

These are placed across field channels to raise the water level to facilitate irrigation. Their function is similar to the cross regulator in the canals. It also serves to confine water to the portion of the water course, which is delivering water to the field to be irrigated.

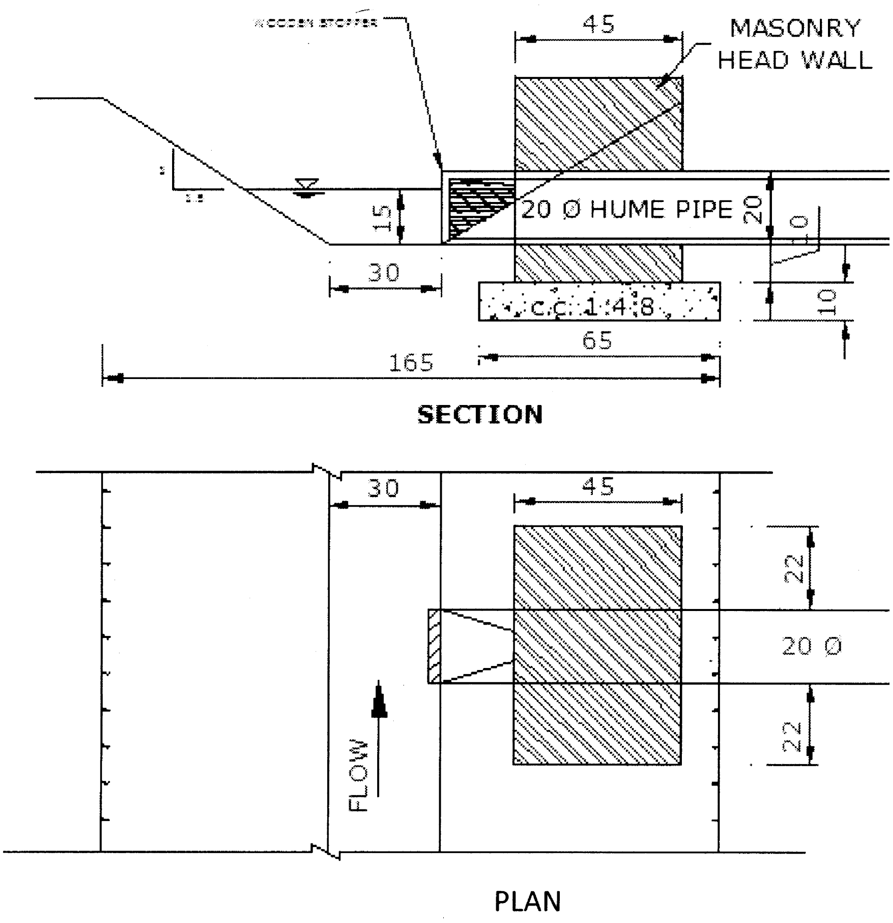
9.5 Turn Out

This is used for releasing water from water course to farm channel or to the field to be irrigated. Its main function is to control the water released in a basin or a strip or a furrow. Turnout could be box type, siphon tube type etc. A typical pipe turn out is shown at Fig. 4.



All dimensions in centimetre.

FIG. 3 DIVISION BOXES



All dimensions in centimetre.

FIG. 4 PIPE TURN OUT (NOT TO SCALE)

9.6 Other Miscellaneous Structures

9.6.1 *Flumes*

These are used to carry water across gullies, ravines and other natural depressions and along steep hill side terrain. Steel, concrete or vitrified clay pipes with semi circular, rectangular or trapezoidal shape are generally used. A typical flume structure is shown at Fig 5A.

9.6.2 *Culverts*

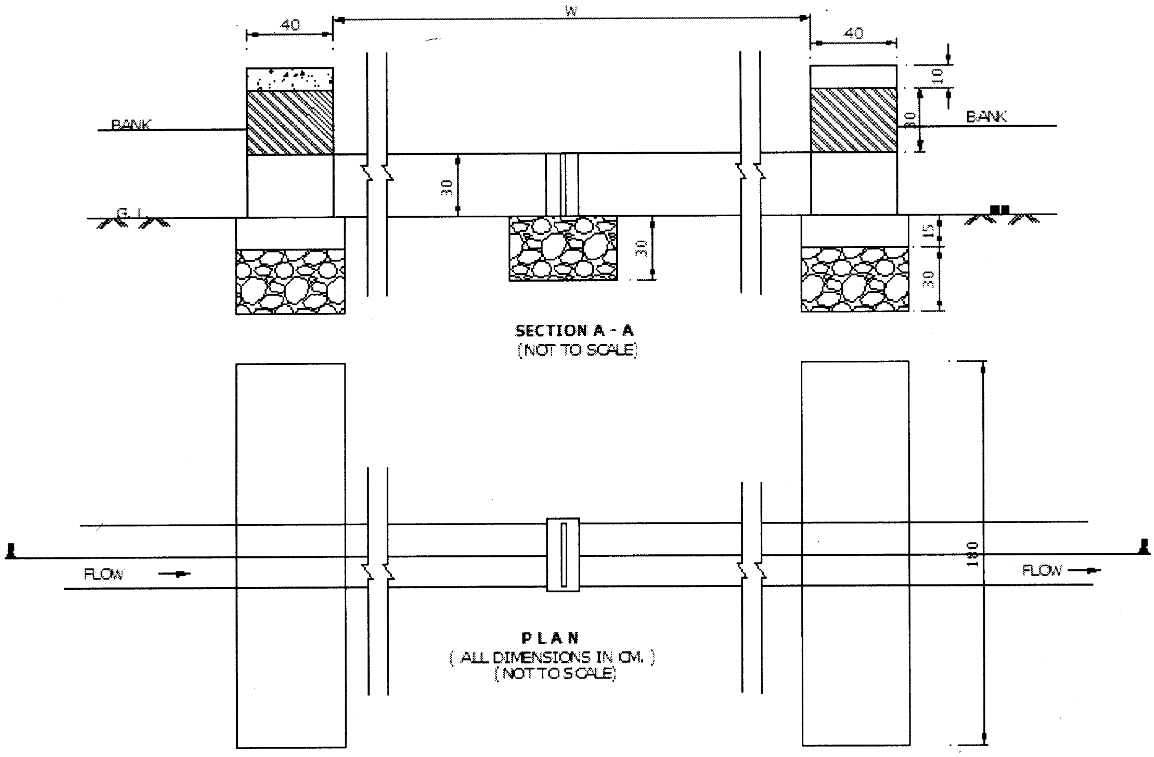
Culverts consist of masonry head walls at inlet and outlet ends, connected together by a buried pipe line and are used at channel crossings. The earth covering the pipe should at least be 30 cm thick (preferably 45 cm or more). A typical culvert structure is shown at Fig. 5B.

9.6.3 *Inverted Siphons*

This type of siphon is more economical when a water course has to cross wide depressions or where the road surface lies close to the field surface. The structure consists of an outlet and outlet tank connected together at their bottom by a pipe. A check gate is provided at the inlet end to control water surface level in the upstream channel. The bottom of tank is kept about 15 cm lower than the bottom of pipe to collect silt. The size of tank should be about 60 cm × 60 cm. The pipe of inverted siphon should be protected by at least 30 cm layer of earth.

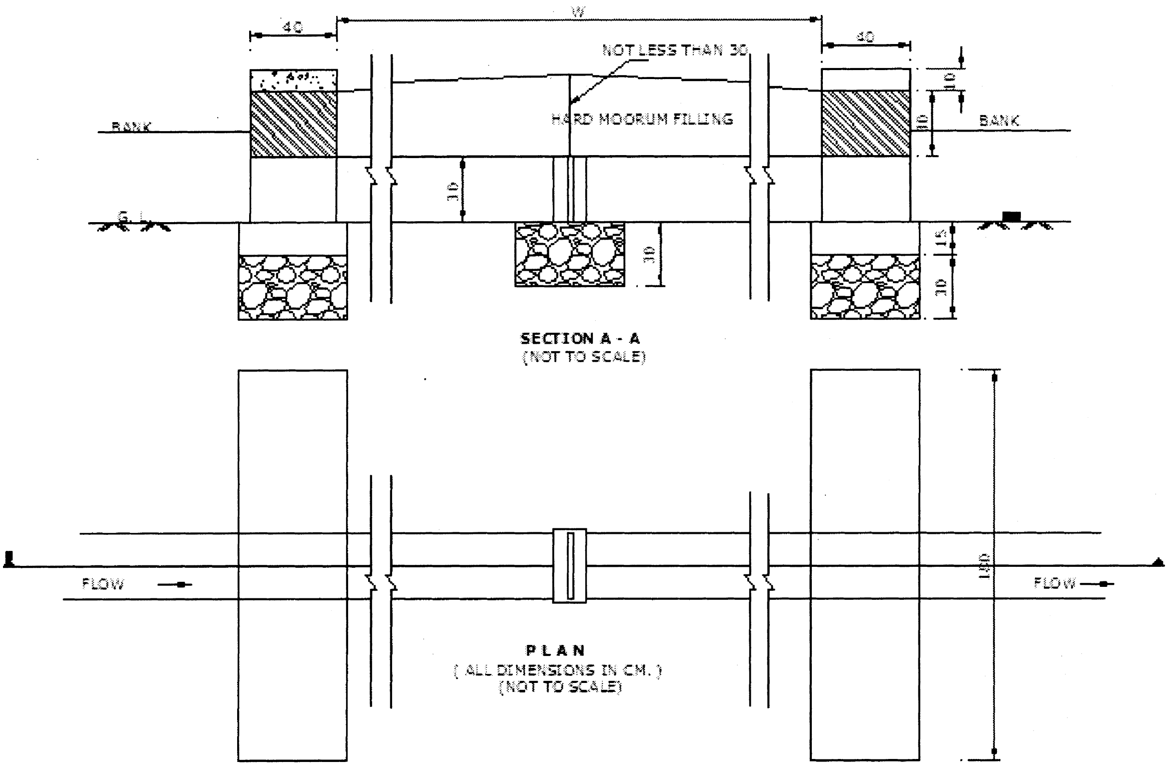
10 STRUCTURES IN BLACK COTTON SOILS

Black cotton soils are associated with alternate expansion and contraction. It is therefore recommended that whenever the soils met with are expansive clays, the depth of foundation should necessarily be below the cracking depth which may be generally taken as 1 to 1.2 m when actual observed data is not available. The foundation should be first filled with well compacted moorum for the depth of about 60 cm over which concrete with nominal reinforcement of 15 cm depth be placed. Uncoursed random (UCR) masonry should be provided above this. The structures in black cotton soil should be of local material for facilitating easy repairs. A typical structure in black cotton soil is shown at Fig. 6.



All dimensions in centimetre.

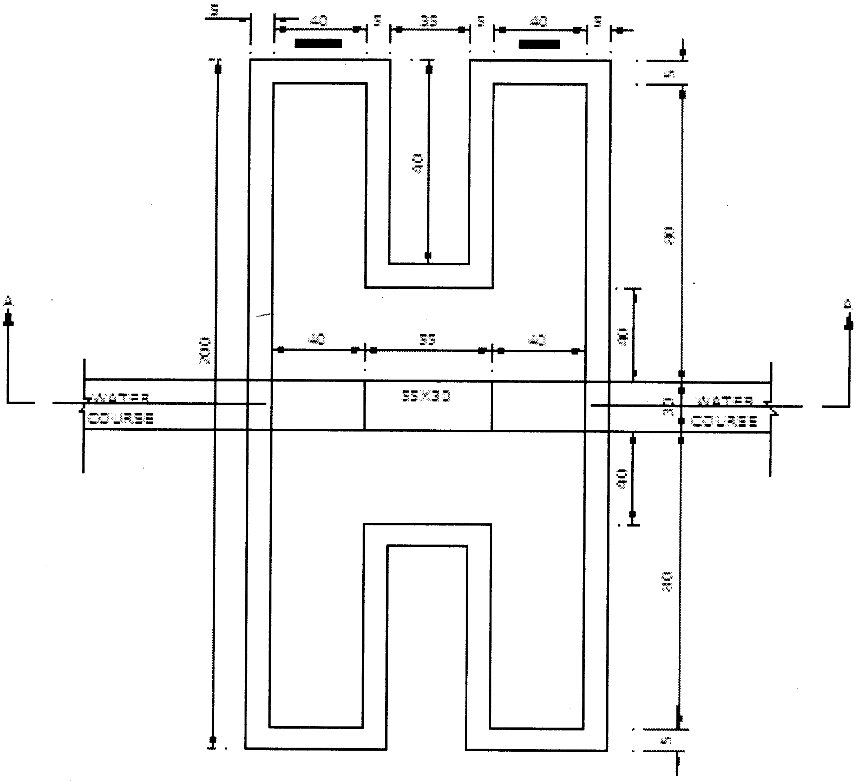
5A Flume Structure



All dimensions in centimetres.

5B Culvert Structure

FIG. 5 OTHER WATER CONTROL STRUCTURES



PLAN
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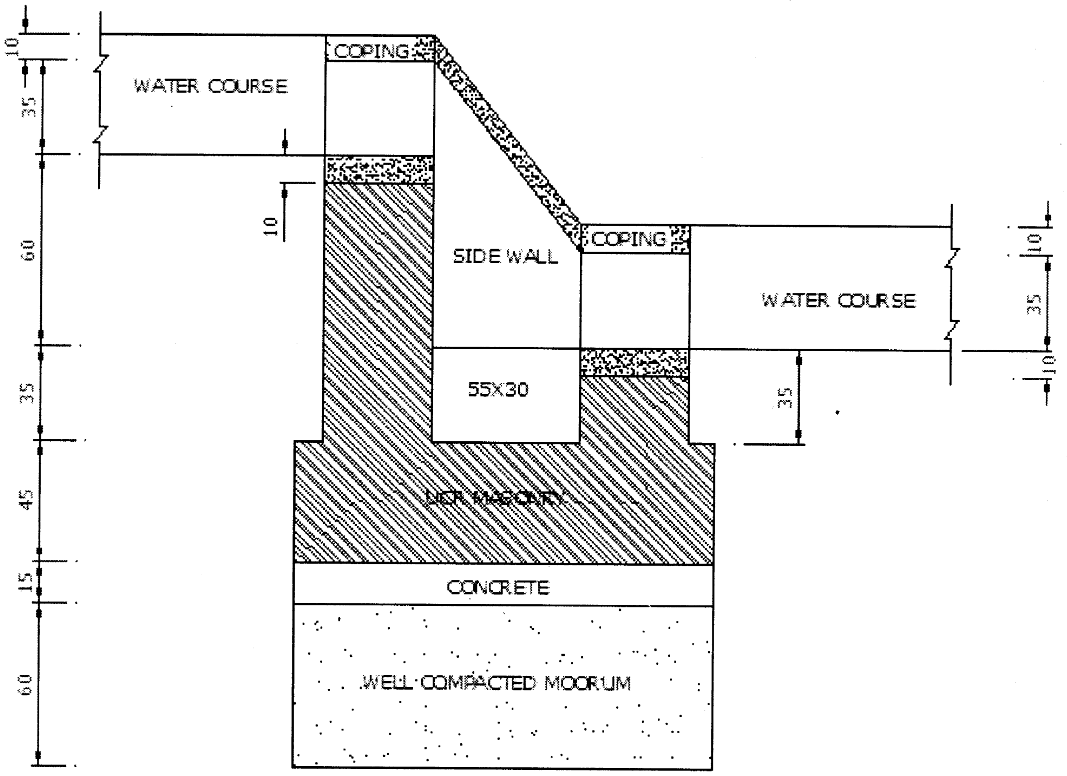

Section A-A (Not to Scale)

All dimensions in centimetre.

FIG. 6 STRUCTURES IN BLACK COTTON SOIL

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Amend No.	Date of Issue	Text Affected

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